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Demand for Commercially Delivered Domestic Fuelwood in Colorado, 1980

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State and regional demand schedules are developed for commercially delivered domestic fuelwood in Colorado. At 1980 prices, there appeared to be little excess demand for commercially delivered fuelwood on a statewide basis; this situation may have changed as such factors as state population, incomes, and oil and gas prices fluctuated in subsequent years.

Keywords: Fuelwood demand, bidding games, contingent valuation, commercially delivered fuelwood

Management Implications

In 1980 across the state, many commercial operators were selling fuelwood at a price below their estimated unit cost; if prices had been set near these unit costs, consumption of commercially delivered fuelwood would have declined considerably. Thus, there is no evidence to indicate that potential existed in 1980 for expanding the home-delivered commercial fuelwood "industry" in Colorado. As the state population, income, conventional fuel bills, wood stove installations, and difficulties in finding supplies for individual collection all continue to increase, demand for commercial fuelwood should increase in the future.

Introduction

In Colorado, as in other areas of the United States, interest in wood as a household fuel has been increasing. Faced with rising fuel bills and tempted by advertisements for an attractive assortment of wood-burning furnaces, airtight stoves, and fireplace inserts, many homeowners have turned to fuelwood in the hope that it will be a cheaper heat source. Others, who may also be economy-minded, are motivated by a concern to shift to a domestic, renewable energy resource. Still others use fireplaces primarily for esthetic reasons, being interested not so much in the heat value as in the "atmosphere" of an open fire. Rising inflation, and increasing energy and environmental awareness, have contributed to a marked rise in the use of fuelwood in Colorado (Ryan and Betters 1982).

This paper evaluates the domestic demand for commercially home-delivered fuelwood in Colorado, that is, fuelwood delivered by commercial vendors. Excluded is fuelwood provided by other commercial suppliers through concessionaire operations and concentration yards in the field and that collected by individuals on both public and private land. It should be noted before proceeding that this study applies to data collected for the 1979–1980 burning season. The fuelwood market appears to be very volatile, and further research is needed to continually update the findings presented here. The question this investigation sought to answer was whether or not excess demand existed, implying a potential in 1980 for expansion of this type of fuelwood "industry." The heat value and esthetics provided by commercially delivered fuelwood are also briefly discussed.

Methods

Since a primary area of investigation in this study was the possibility of excess demand, a contingent valuation approach was taken (as opposed to an analysis of "market data"). The contingent valuation approach has been discussed at some length elsewhere (e.g., Randall

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et al. 1974, Brookshire et al. 1976, Brookshire and Crocker 1979). This approach, also called the bidding game approach, attempts to value outputs by surveying the relevant potential consumers and directly questioning them regarding their willingness to pay.

For reasons of practicality, a mail survey was utilized. The state was divided into five regions (fig. 1) based on the population distribution, natural geographical boundaries, and available fuelwood supplies. Because the study was conducted on this region-by-region basis, differences between regions of the state were made readily discernible. In 1980, 3000 questionnaires were mailed to households throughout Colorado; 600 questionnaires were sent to households in each region, dispersed according to the regional population distribution. The households were randomly sampled from telephone directories and a mailing list provided by the Colorado Rural Electric Association. The entire survey is reproduced in Ryan (1981). The contingent valuation was only one of several purposes of the survey, which investigated many aspects of fuelwood consumption in Colorado. The data available for demand analysis was thus somewhat limited, requiring a simple approach.

The contingent valuation question asked: "How many cords of delivered fuelwood would you purchase, for this year's needs, at the following prices?" The set of prices ranged from \$25 to \$200 per cord. This is a simple approach, but it provides the data for a basic demand analysis.

A total of 725 usable questionnaires were completed and returned by households. The response varied from 13% to 33% of the total questionnaires sent in each region. The Statistical Package for the Social Sciences (SPSS) was used to develop appropriate statistics, including regression equations for demand schedules. The regional responses were weighted by both number of questionnaires returned and the total regional population, and the regional figures were combined to estimate state-level statistics. Based on Colorado Division of Housing figures for total number of households, the sample was projected to total state and regional levels. Also, a statewide sample of 30 nonrespondents was drawn to test for response bias. This test (t-test, $p=0.05$) showed that, for the state as a whole, the percentage of households that were fuelwood purchasers did not vary in a statistically significant manner between respondents and nonrespondents. The most probable source for response bias would be that fuelwood purchasers would respond more frequently than less interested parties. Thus, the t-test provides some evidence that the results of this study are not biased by survey nonresponses.

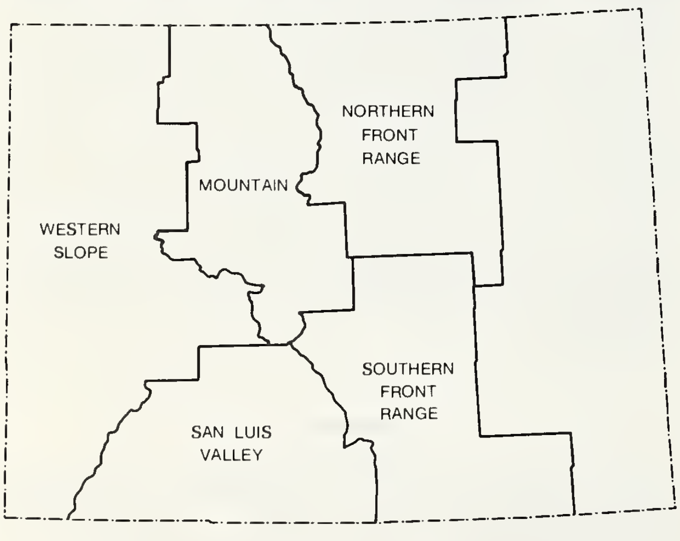

Figure 1. The five areas used for regional analysis of fuelwood use in Colorado.

Demand Schedules for Commercially Delivered Fuelwood in Colorado

Demand schedules regressed on the survey data are given in table 1. The double $\log_e$ functional form was chosen on the basis of explanatory power (R^2). These regressions were run on the projected state and regional consumption figures, at different prices.

Table 1.—Willingness to pay functions,[1] 1980
(Q = cords; P = price/cord)

Group	Demand function	R^2
State	$P = e^{(9.6-0.448 \ln Q)}$	95.3
Northern Front Range	$P = e^{(9.7-0.473 \ln Q)}$	94.1
Southern Front Range	$P = e^{(7.2-0.304 \ln Q)}$	92.1
San Luis Valley	$P = e^{(7.1-0.377 \ln Q)}$	91.9
Mountain	$P = e^{(10.7-0.698 \ln Q)}$	97.1
Western Slope	$P = e^{(7.9-0.386 \ln Q)}$	94.6

[1]*Because 70% of the fuelwood burned is either ponderosa pine or lodgepole pine, it can be assumed that the price per cord (P) cited by respondents was based on their use of those species types.*

As can be seen, the demand functions varied across regions. Because most of the state's population reside in the Northern Front Range area, the state and Northern Front Range willingness to pay (WTP) schedules were similar—both had fairly high WTP for initial volumes. The Mountain Region also had a high WTP for initial volumes, but this declined quickly, probably because of the households in ski resort communities that were willing to pay considerably more than most other households, but at the same time used a relatively small volume regionwide. In most other regions WTP was less for initial fuelwood volumes, but the curves for these regions decreased at a slower rate as the volumes got larger.

Other exogenous variables, not explicitly used in the willingness to pay functions, influence WTP. For example, along the Northern Front Range, where WTP was highest, more than 45% of the households surveyed considered finding adequate fuelwood supplies to cut a serious problem. Only about 30% of households in other regions expressed this same concern. Average round-trip distance traveled to cut fuelwood was 100 miles along the Northern Front Range as compared to 35 miles elsewhere. This scarcity of fuelwood to be collected by the individual probably caused WTP for commercially

delivered fuelwood to be higher in the Northern Front Range than in other regions.[2]

Income also influences WTP. Higher income groups are generally willing to pay more for fuelwood. The fact that 80% of Colorado's higher income households live in the Northern Front Range probably contributed to the higher WTP schedule there. Finally, the wood burner used would have an influence on WTP. Those using wood stoves probably would not be willing to pay as much for fuelwood as they use larger quantities of fuelwood and its cost has more of an impact on their cash flow. They may also be familiar with alternative means of improving efficiency or conservation measures and may be able to use substitutes such as coal. The fact that, on a proportional basis, more fuelwood is burned in wood stoves in regions outside the Northern Front Range, could contribute to the lower WTP schedules in these regions. Further, there may be some cross-correlation between type of wood burner used and income level.[3]

Implications of Demand Functions

The survey estimated state consumption of commercially delivered fuelwood to be 147,000 cords at an average price of $66 per cord during the 1979–1980 burning season (fig. 2, point A). The state demand curve would predict a marginal willingness to pay for 147,000 cords to be about $71.50 (point B). At a price of $66 per cord, the state demand curve would predict a quantity demanded of 175,731 cords (point C). This provides some indication that relatively little excess (or latent) demand existed for delivered fuelwood in Colorado at 1980 prices.[4] The state demand curve predicts a quantity demanded relatively close to 1980 consumption with the 1980 average price.

As an example of how these quantity demanded figures are calculated, take the state demand function. The double $\log_e$ equation can be solved as follows:

$$P = e^{(9.6-0.448 \ln Q)}$$
$$P = e^{9.6}\, Q^{-0.448}$$
$$P = 14{,}765\, Q^{-0.448}$$

[2]*In the mid-1970's there were large amounts of accessible fuelwood because a mountain pine beetle epidemic had killed large numbers of ponderosa pine in the area. About this time there was also a major increase in heating bills and a corresponding increase in fuelwood use and a shift to heating with wood. More than 50% of the airtight wood stoves used along the Front Range were installed after 1975 (Ryan and Betters 1982).*

[3]*The quantitative relationships between fuelwood price and exogenous variables such as income, wood burner used, and availability of supplies is not yet known, but these relationships are being studied as part of an on-going research project concerning fuelwood markets.*

[4]*It should also be noted that a substantial consumer surplus above a price of $66 is indicated by the demand curve in figure 2—approximately $5 million. Consumer surplus is the amount consumers would have been willing to pay but did not at the current price. In this case, geometrically, it is the total area between the demand schedule and the $66 price horizontal.*

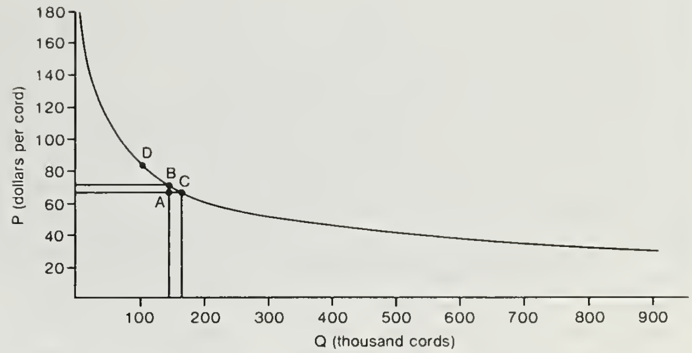

Figure 2. Fuelwood willingness-to-pay schedule for the State of Colorado (1979–1980 season).

Thus, at a price of $66, Q is:

$$66 = 14{,}765\, Q^{-0.448}$$
$$0.00447 = Q^{-0.448}$$
$$(0.00447)^{-1/0.448} = (Q^{-0.448})^{-1/0.448} = Q$$
$$175{,}731 = Q$$

Such an inversion of a log-log regression may be biased; however, with strong goodness-of-fit (as in this case) any error should be very small.

Supply (cost) schedules for commercially produced fuelwood, statewide and regionally, are not available; however, there is a recent study of commercial fuelwood vendor operations in Colorado that estimated the cost per cord in 1980 to be $73.20 (Switzer 1981). Three recent USDA Forest Service appraisals for Colorado fuelwood sales estimated the production costs to be $92, $85, and $80 per cord.[5] The average of these four figures is roughly $83. Based on these figures, 1980 prices were less than unit costs per cord of commercially delivered fuelwood. The demand curve in figure 2 would predict that at a price of $83, only about 105,000 cords would be demanded (point D).

Within the commercial fuelwood market, certain fuelwood vendors may have had costs greater than their returns. Their actual costs were not being passed on to the consumer. This can be partially explained by the nature of many of the commercial fuelwood vendors' businesses. Many of these vendors operate only on a part-time basis (58% of the vendors in Colorado are classed as part-time) and sometimes collect fuelwood as part of a recreational outing or as an activity to provide some extra income. All their true costs (particularly equipment investment costs and time) may not be considered in their fuelwood production decisions. The easy entry and exit to the market also makes it possible for a fair proportion of the sellers to be "on the way out of business." These factors could combine to create a situation where fuelwood is often sold for less than its production costs.

[5]*Total production costs of the 1980 "Jug Gulch Sale," 1982 "Homestead Sale," and 1982 "Bear Gulch Sale." Total production costs in these three appraisals and in Switzer (1981) include stumpage fees, logging, splitting, transportation, and overhead involved in producing commercial fuelwood.*

It is likely that the demand will increase (the curve will shift outward) in the future as state incomes, conventional fuel prices, and population continue to increase. The survey results indicated that if prices of conventional fuels increased 25% there would be a 10% increase in households using wood stoves; and for a 100% increase in conventional fuel prices there would be a 39% increase in households using wood stoves. Because households using wood stoves generally burn more cords (1.6 cords per fireplace per year versus 3.9 cords per wood stove per year) and are likely to continue burning wood, one might expect a significant shift in consumption due to this change alone (Ryan and Betters 1982). State population, expected to increase by 10% between 1980 and 1990, will also contribute to an increase in commercially delivered fuelwood demand. Finally, possible reductions in readily accessible fuelwood for individual collection would cause individual collectors to shift to buying their fuelwood from commercial vendors.

Esthetic and Heating Values

Additional insights concerning fuelwood use can be gained by comparing WTP to the value of conventional fuel that fuelwood replaces. In 1979, a cord of pine burned in an airtight stove replaced about $70 worth of natural gas; in a nonairtight stove, it replaced about $35 worth of natural gas; in a fireplace, it replaced about $17 worth of natural gas (Gray et al. 1979). Weighing these figures by the proportion of cords burned in each stove type shows the statewide average heat value replaced to be about $34 per cord. Given the 1980 price ($66), as well as the marginal willingness to pay indicated in figure 2 ($71.50 at 1980 consumption levels), it seems that marginal willingness to pay for fuelwood was more than was apparently returned in conventional fuel bill savings.

Assuming that consumers are aware of the heating value of wood, the difference between WTP and the value of conventional fuel cost saved could be interpreted as the esthetic value of burning the wood. If one considers burning in a fireplace ($17 per cord heat value in 1980), the difference between marginal willingness to pay and heat value was quite large—about $54.50 ($71.50 – $17.00). This is significant because 60% of the cords burned in 1980 in the state were burned in fireplaces (Ryan and Betters 1982). With more efficient wood burners, the heating value replaced would have been higher. In fact, for airtight stoves, the conventional fuel bill savings would have been very close to the marginal willingness to pay indicated in figure 2. These comparisons are, of course, very rough, and could alternatively be explained as nothing more than a lack of knowledge on the consumers' part regarding the heating value of wood.

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